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Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i)) for all designations
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations
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(54) Title: POLYPROPYLENE FOAM AND FOAM CORE STRUCTURE

(57) Abstract: One or more external surfaces of an extruded foam are coated by co-extruding a skin of polymer on the surface to reduce the diffusion the foaming gases out of the cells of the solidifying polymer foam. The sealing effect can involve coating one side of the extruded foam (AB foam) or both sides (ABA form). The skins can be solid or foamed. Alternatively, a cylinder is formed from an annular die and, preferably, a cylindrical cooling mandrel. By extruding and drawing the cylinder of foam onto a cooled cylindrical mandrel, which expands the diameter of the cylinder, the optimum physical properties of the structure can be achieved. This is because the foam structure is stretched in longitudinal and lateral directions. Preferable, the foaming polymer has "inherent melt strength" and "strain hardening" so that the foam cells are more consistent in size and shape. The preferred polymers are polypropylene or polystyrene.



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AMENDED CLAIMS

[received by the International Bureau on 06 November 2003 (06.11.03)
original claims 1 to 25 replaced by amended claims 1 to 94 (10 pages)]

1. A multilayer polymeric structure formed from a co-extrudate of a foamable core composition and a first skin extrudate layer joined to a first surface of said prefoamed core composition and a second extrudate layer joined to a second surface of said prefoamed core composition which comprises:

(a) a foamed core formed from said foamable core composition and comprising a polymer having cells filled with a gas, said first surface and said second surface, and

(b) a first polymeric skin layer formed from said first skin extrudate layer joined to said first surface and a second polymeric skin layer from said second extrudate layer joined to said second surface.

2. The structure of Claim 1 having a cylindrical shape.

3. The structure of Claim 1 having a flat shape.

4. The structure of Claim 1 wherein said first polymeric skin layer and said second polymeric skin layer have the same composition.

5. The structure of Claim 2 wherein said first polymeric skin layer and said second polymeric skin layer have the same composition.

6. The structure of Claim 3 wherein said first polymeric skin layer and said second polymeric skin layer have the same composition.

7. The structure of Claim 1 wherein said first polymeric skin layer and said second polymeric skin layer have a different composition.

8. The structure of Claim 2 wherein said first polymeric skin layer and said second polymeric skin layer have a different composition.

9. The structure of Claim 3 wherein said first polymeric skin layer and said second polymeric skin layer have a different composition.

10. The structure of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8 or 9 wherein said foamed core is formed of polypropylene.

11. The structure of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8 or 9 wherein said foamed core is formed of polystyrene.

12. The structure of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8 or 9 wherein at least one of said skin layers contains an additive.

13. The structure of any one of Claim 12 wherein at least one of said skin layers contains an additive selected from the group consisting of an organic additive, an inorganic additive, a granular additive, a powdered additive, a crystalline additive and a fibrous additive.

14. The structure of Claim 12 wherein said core is formed of polypropylene.

15. The structure of Claim 13 wherein said core is formed of polypropylene.

16. The structure of Claim 12 wherein said core is formed of polystyrene.

17. The structure of Claim 13 wherein said core is formed of polystyrene.

18. The structure of any one of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8 or 9 wherein at least one of said skin layers is solid.

19. The structure of any one of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8 or 9 wherein at least one of said skin layers is a foam.

20. The structure of Claim 18 wherein said core is formed of polypropylene.
21. The structure of Claim 19 wherein said core is formed of polypropylene.
22. The structure of Claim 18 wherein said core is formed of polystyrene.
23. The structure of Claim 19 wherein said core is formed of polystyrene.
24. The structure of any one of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8 or 9 wherein at least one of said skin layers comprises a composition selected from the group consisting of polypropylene, silylated polyethylene, polyethylene, metallocene polyethylene, and ethylene vinyl acetate.
25. The structure of Claim 24 wherein said core is polypropylene.
26. The structure of Claim 24 wherein said core is polystyrene.
27. A method for forming a multilayer polymeric structure which comprises:
- (a) mixing a first polymer with a blowing agent to form a foamable composition having a first surface and a second surface and
 - (b) co-extruding said foamable composition with a second polymer composition and with a third polymer composition to form a co-extrudate comprising:
(1) a foamed core having said first surface and said second surface, (2) a first skin layer formed of said second polymer composition joined to said first surface and (3) a second skin layer formed of said third polymer composition joined to said second surface.
28. The method of Claim 27 wherein said blowing agent is a composition selected from the group consisting of a chemical blowing agent, a physical blowing agent and mixtures thereof.

29. The method of Claim 27 wherein said co-extrudate has a cylindrical shape.
30. The method of Claim 28 wherein said co-extrudate has a cylindrical shape.
31. The method of Claim 27 wherein said co-extrudate has a flat shape.
32. The method of Claim 28 wherein said co-extrudate has a flat shape.
33. The method of any one of Claims 27, 28, 29, 30, 31 or 32 wherein said first polymer is polypropylene.
34. The method of any one of Claims 27, 28, 29, 30, 31 or 32 wherein said first polymer is polystyrene.
35. The method of Claim 29 wherein said cylindrical co-extrudate is slit to form an open sheet.
36. The method of Claim 30 wherein said cylindrical co-extrudate is slit to form an open sheet.
37. The method of Claim 35 wherein said first polymer is polypropylene.
38. The method of Claim 36 wherein said first polymer is polypropylene.
39. The method of Claim 35 wherein said first polymer is polystyrene.
40. The method of Claim 36 wherein said first polymer is polystyrene.
41. The method of Claim 27 wherein said second polymer composition and said third polymer composition are the same.

42. The method of Claim 28 wherein said second polymer composition and said third polymer composition are the same.

43. The method of Claim 29 wherein said second polymer composition and said third polymer composition are the same.

44. The method of Claim 30 wherein said second polymer composition and said third polymer composition are the same.

45. The method of Claim 31 wherein said second polymer composition and said third polymer composition are the same.

46. The method of Claim 32 wherein said second polymer composition and said third polymer composition are the same.

47. The method of Claim 33 wherein said second polymer composition and said third polymer composition are the same.

48. The method of Claim 34 wherein said second polymer composition and said third polymer composition are the same.

49. A method for forming a multilayer polymeric structure which comprises:

- (a) mixing a first polymer with a blowing agent to form a foamable composition having a first surface and a second surface and
- (b) co-extruding said foamable composition with a second polymer composition and with a third polymer composition to form a cylindrical co-extrudate comprising: (1) a foamed core having said first surface and said second surface, (2) a first skin layer formed of said second polymer composition joined to said first surface and (3) a second skin layer formed of said third polymer composition joined to said second surface,

(c) said co-extruding step (b) being effected by passing said cylindrical co-extrudate over a mandrel such that said mandrel is positioned within said cylindrical co-extrudate and by passing a gas from said mandrel in a direction countercurrent to a direction of movement of said co-extrudate from a co-extrusion head to position said co-extrudate away from contact with said mandrel.

50. The method of Claim 49 wherein said blowing agent is a composition selected from the group consisting of a chemical blowing agent, a physical blowing agent and mixtures thereof.

51. The method of any one of Claims 49 or 50 wherein said first polymer is polypropylene.

52. The method of any one of Claims 49 or 50 wherein said first polymer is polystyrene.

53. The method of Claim 49 wherein said cylindrical co-extrudate is slit to form an open sheet.

54. The method of Claim 50 wherein said cylindrical co-extrudate is slit to form an open sheet.

55. The method of Claim 49 wherein said first polymer is polypropylene.

56. The method of Claim 50 wherein said first polymer is polypropylene.

57. The method of Claim 49 wherein said first polymer is polystyrene.

58. The method of Claim 50 wherein said first polymer is polystyrene.

59. The method of Claim 49 wherein said gas directed from said mandrel is removed from contact with said cylindrical co-extrudate by being passed into said mandrel.

60. The method of Claim 59 wherein said blowing agent is a composition selected from the group consisting of a chemical blowing agent, a physical blowing agent and mixtures thereof.

61. The method of any one of Claims 59 or 60 wherein said first polymer is polypropylene.

62. The method of any one of Claims 59 or 60 wherein said first polymer is polystyrene.

63. The method of Claim 59 wherein said cylindrical co extrudate is slit to form an open sheet.

64. The method of Claim 60 wherein said cylindrical co-extrudate is slit to form an open sheet.

65. The method of Claim 49 wherein said second polymer composition and said third polymer composition are the same.

66. The method of Claim 50 wherein said second polymer composition and said third polymer composition are the same.

67. The method of Claim 51 wherein said second polymer composition and said third polymer composition are the same.

68. The method of Claim 52 wherein said second polymer composition and said third polymer composition are the same.

69. The method of Claim 53 wherein said second polymer composition and said third polymer composition are the same.

70. The method of Claim 54 wherein said second polymer composition and said third polymer composition are the same.

71. The method of Claim 55 wherein said second polymer composition and said third polymer composition are the same.

72. The method of Claim 56 wherein said second polymer composition and said third polymer composition are the same.

73. The method of Claim 57 wherein said second polymer composition and said third polymer composition are the same.

74. The method of Claim 58 wherein said second polymer composition and said third polymer composition are the same.

75. The method of Claim 59 wherein said second polymer composition and said third polymer composition are the same.

76. The method of Claim 60 wherein said second polymer composition and said third polymer composition are the same.

77. The method of Claim 61 wherein said second polymer composition and said third polymer composition are the same.

78. The method of Claim 62 wherein said second polymer composition and said third polymer composition are the same.

79. The method of Claim 63 wherein said second polymer composition and said third polymer composition are the same.

80. The method of Claim 64 wherein said second polymer composition and said third polymer composition are the same.

81. The polymer structure of any one of Claims 1, 2 or 3 which includes at least one third polymeric skin layer on either the first polymeric skin layer or the second polymeric skin layer.

82. The method of any one of Claims 27, 28, 29, 30, 31 or 32 wherein at least one third skin layer is co-extruded either on said first skin layer or said second skin layer.

83. The method of any one of Claims 49, 50, 53 or 54 wherein at least one third skin layer is co-extruded either on said first skin layer or said second skin layer.

84. The structure of any one of Claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 14 or 15 wherein said foamed core is formed of a polymeric composition selected from the group consisting of a blend of polypropylenes, polypropylene and polyethylene, and polypropylene and metallocene based polypropylene.

85. The method of Claim 82 wherein at least one of said skin layers contains an additive.

86. The method of Claim 83 wherein at least one of said skin layers contains an additive.

87. The method according to claim 49, wherein the first skin layer is solid.

88. The method according to claim 87, wherein the second skin layer is solid.

88. The method according to claim 49, wherein the first skin layer is foamed.

89. The method according to claim 88, wherein the second skin layer is foamed.

90. The method according to claim 49, further including at least one further skin layer disposed over at least one of the first and second skin layers.

91. The method according to claim 49, further including third and fourth skin layers disposed on the first skin layer.

92. The method according to claim 91, wherein at least one of the first, second, third and fourth skin layers includes an additive.

93. The method according to claim 91, wherein a first one of the first, second, third and fourth skin layers is solid and a second one of the first, second, third, and fourth skin layers is foamed.

94. The method according to claim 49, further including third, fourth and fifth skin layers disposed on at least one of the first and second skin layers.

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : C08J 9/10, 9/12, 9/14
US CL : 521/79, 81, 82, 97, 134

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 521/79, 81, 82, 97, 134

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST 1.4

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,817,705 A (WILKES et al) 06 October 1998 (06.10.1998) col.3 lines 60-67, col. 8 line 66 to col. 9.line 9 and EXAMPLE 7 and 8 in cols. 22 and 23.	1-25
A	US 6,417,242 B1 (HUGHES et al) 09 July 2002 (09.07.2002) entire document	1-25

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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